

RESEARCH ARTICLE

Antibacterial Assessment of Zinc Sulfide Nanoparticles against *Streptococcus pyogenes* and *Acinetobacter baumannii*

Zeinab Morshedtalab¹, Ghasem Rahimi², Asieh Emami-Nejad³, Alireza Farasat⁴, Azita Mohammadbeygi⁵, Nahid Ghaedamini³ and Masoud Negahdary^{6,*}

¹Iran Food and Drug Administration, Tehran, Iran; ²Agro Industrial Complex of Medicinal Plants (SPAD), Shiraz, Iran; ³Department of Biology, Payame Noor University (PNU), P.O.Box 19395-3697, Tehran, Islamic Republic of Iran; ⁴Cellular and Molecular Research Center, Research Institute for prevention of Non- Communicable Disease, Qazvin University of Medical Sciences, Qazvin, Iran; ⁵Department of Immunology, Shahid Beheshti International University, Tehran, Iran; ⁶Yazd Cardiovascular Research Center, Shahid Sadoughi University of Medical Sciences, Yazd, Iran

Abstract: Background: Due to the appearance of resistant bacterial strains against the antimicrobial drugs and the reduced efficiency of these valuable resources, the health of a community and the economies of countries have been threatened. Objective: In this study, the antibacterial assessment of zinc sulfide nanoparticles (ZnS NPs) against *Streptococcus pyogenes* and *Acinetobacter baumannii* has been performed.

Methods: ZnS NPs were synthesized through a co-precipitation method using polyvinylpyrrolidone (PVP), polyvinyl alcohol (PVA) and polyethylene glycol (PEG-4000). The size and morphology of the synthesized ZnS NPs were determined by a scanning electron microscope (SEM) and it was found that the average size of the applied NPs was about 70 nm. In order to evaluate the antibacterial effect of the synthesized ZnS NPs, various concentrations (50 µg/mL, 100 µg/mL and 150 µg/mL) of ZnS NPs were prepared. Antibacterial assessments were performed through the disc diffusion method in Mueller Hinton Agar (MHA) culture medium and also the optical density (OD) method was performed by a UV-Vis spectrophotometer in Trypticase™ Soy Broth (TSB) medium. Then, in order to compare the antibacterial effects of the applied NPs, several commercial antibiotics including penicillin, amikacin, ceftazidime and primaxin were used.

Results: The achieved results indicated that the antibacterial effects of ZnS NPs had a direct relation along with the concentrations and the concentration of 150 µg/mL showed the highest antibacterial effect in comparison with others. In addition, the ZnS NPs were more effective on *Acinetobacter baumannii*.

Conclusion: The findings of this research suggest a novel approach against antibiotic resistance.

Keywords: Zinc sulfide nanoparticles, Antibacterial effects, *Streptococcus pyogenes*, *Acinetobacter baumannii*, Antimicrobial resistance, Antibiotic resistance.

1. INTRODUCTION

Antibiotics react against bacteria in different ways to eliminate and reduce infection growth [1, 2]. The recognized platforms for such reactions include DNA destruction, cell wall degradation, directed effects on the cytoplasmic membrane, prevention of protein synthesis and anti-metabolites [3, 4]. The bacterial resistance occurs when mutations are enabled in the bacteria and they establish resistance against antibiotic drugs and new generations of them appear that cannot be fought against them easily [5]. The main cause of this type of drug resistance is self-treatment or excessive use

of antibiotics [6]. This phenomenon endangers the entire human society [7]. Bacterial resistance against antibiotics is one of the biggest challenges in the modern age that threatens human health [7-9]. *Streptococcus pyogenes* is a gram-positive cocci; it is thought that about 700 million infections are caused by this bacteria annually and 650 thousands of these infections are severe and harmful (Fig. 1b) [10, 11]. The mortality rate is about 25% for infections caused by this pathogen [12]. This bacterium creates important diseases in humans. Pharyngitis, impetigo, erysipelas, cellulitis and necrotizing fasciitis are some diseases caused by this pathogen [13, 14]. So far, penicillin and ampicillin are used as the most effective medical treatments against *Streptococcus pyogenes*. Compared with gram-positive bacteria, gram-negative bacteria are more resistant against antibiotics due to their impenetrable walls [15, 16]. *Acinetobacter* is a type of

*Address correspondence to this author at the Yazd Cardiovascular Research Center, Shahid Sadoughi University of Medical Sciences, Yazd, Iran; Tel: +989124758568; E-mail: Masoudnegahdary@ssu.ac.ir; masoudnegahdary@yahoo.com.